US006409294B1

(12) **United States Patent**
Zimmermann et al.

(10) **Patent No.: US 6,409,294 B1**
(45) **Date of Patent: Jun. 25, 2002**

(54) **DIGITAL POSTAGE FRANKING WITH COHERENT LIGHT VELOCIMETRY**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **09/573,646**

(22) Filed: **May 18, 2000**

Related U.S. Application Data

(63) Continuation of application No. 09/023,457, filed on Feb. 13, 1998.

(60) Provisional application No. 60/068,434, filed on Dec. 22, 1997.

(51) **Int. Cl.**[7] **B41J 3/00**

(52) **U.S. Cl.** **347/2**

(58) **Field of Search** 347/2, 19, 14, 347/23, 16; 356/28.5; 73/1.41; 705/408

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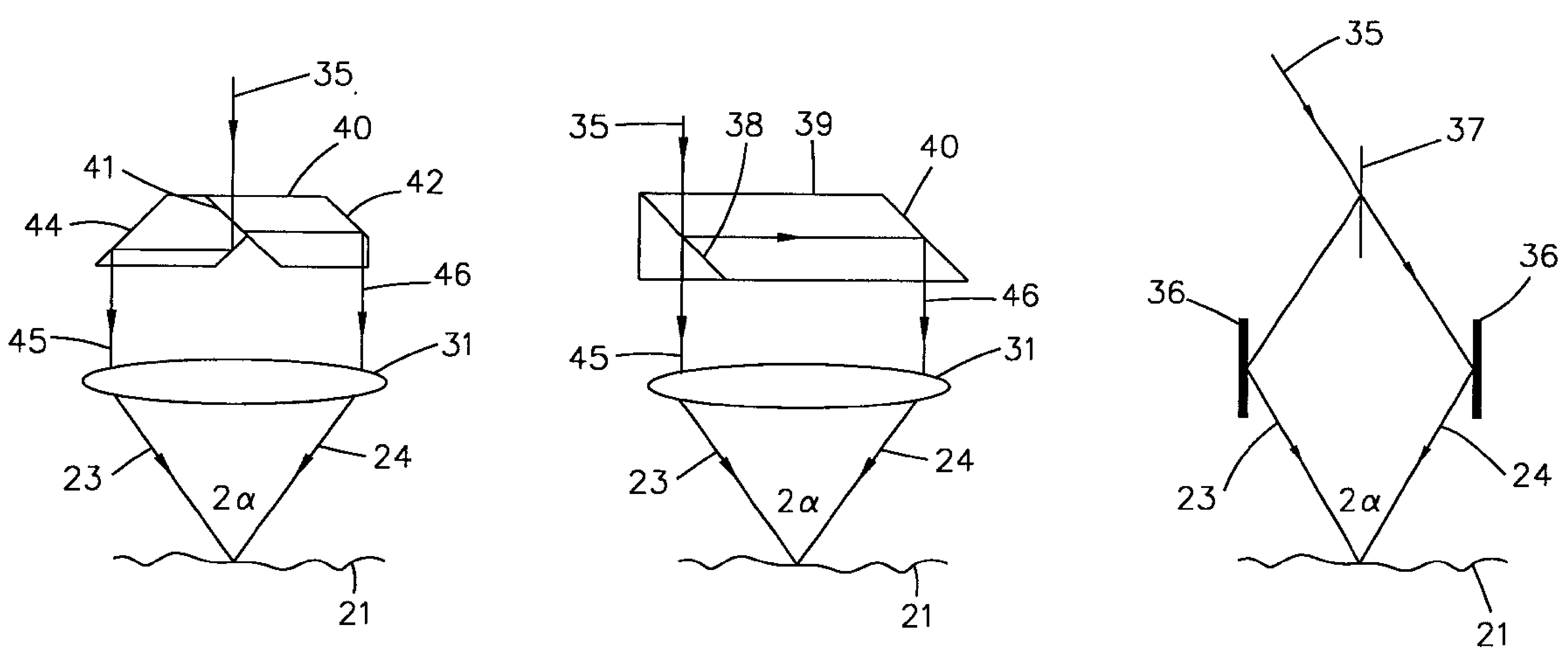
(57) **ABSTRACT**

A postage meter (franking machine) uses a digital print head such as an ink-jet or thermal transfer or dot-matrix print head, for which it is necessary to know the velocity of the mail piece passing by the print head. Two collimated monochromatic beams strike the mail piece, one at an angle leading the mail piece velocity and the other at an angle lagging the mail piece velocity. The beams converge yielding a sensing region filled with a diffraction pattern. The mail piece, assumed to be rough at a scale that is appropriate for the velocity measurement, moves at some velocity. A detector detects light intensity (photon flux) at a small region within the sensing region, and the intensity signal has a frequency that is proportional to the mail piece velocity. The frequency is detected or measured, the instantaneous velocity is derived therefrom, and the velocity is used to control the print head. In this way a two-dimensional print image (postage indicium) is faithfully printed on the mail piece with minimal distortion even in the event of non-constant velocity of the mail piece.

20 Claims, 7 Drawing Sheets



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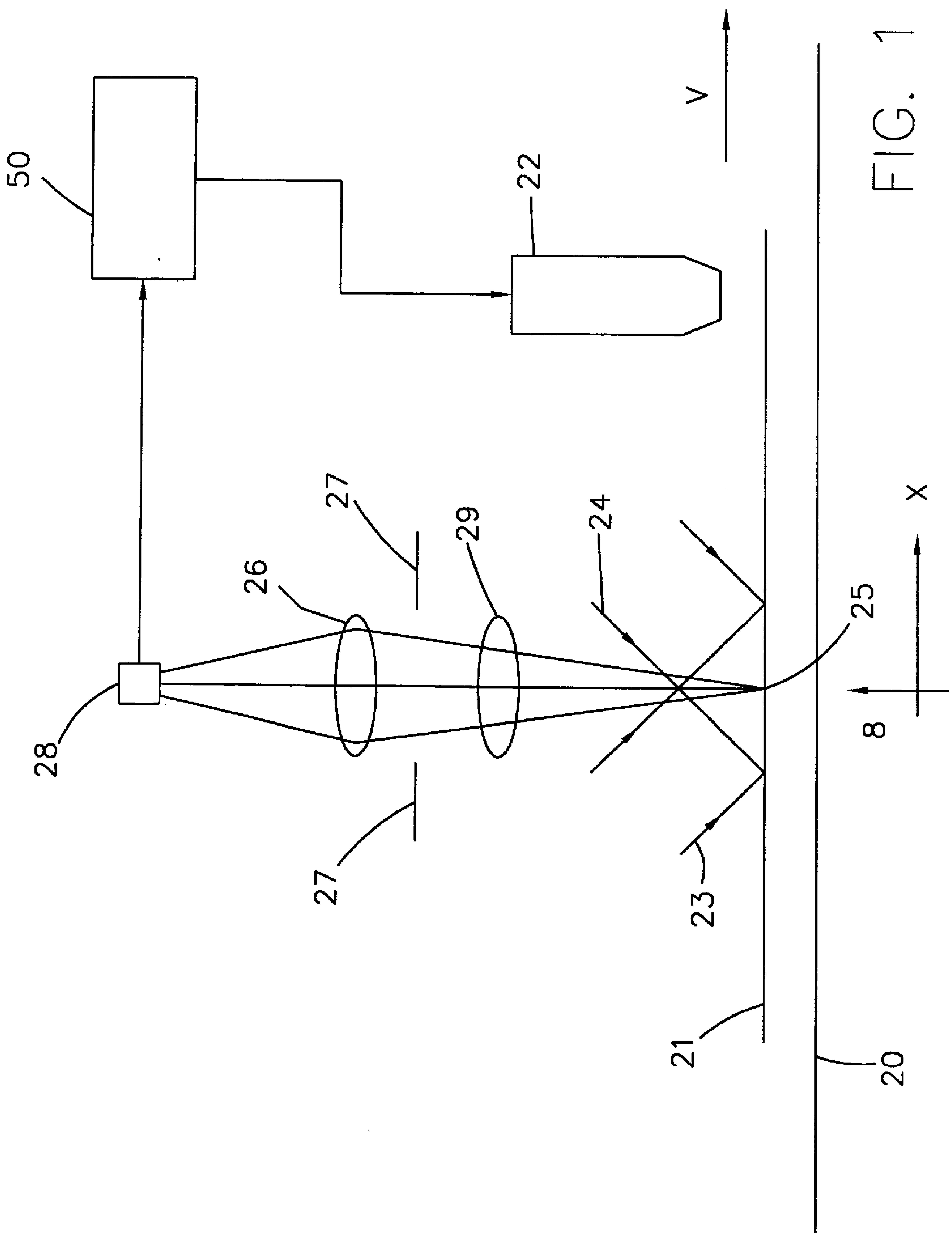

FIG. 1

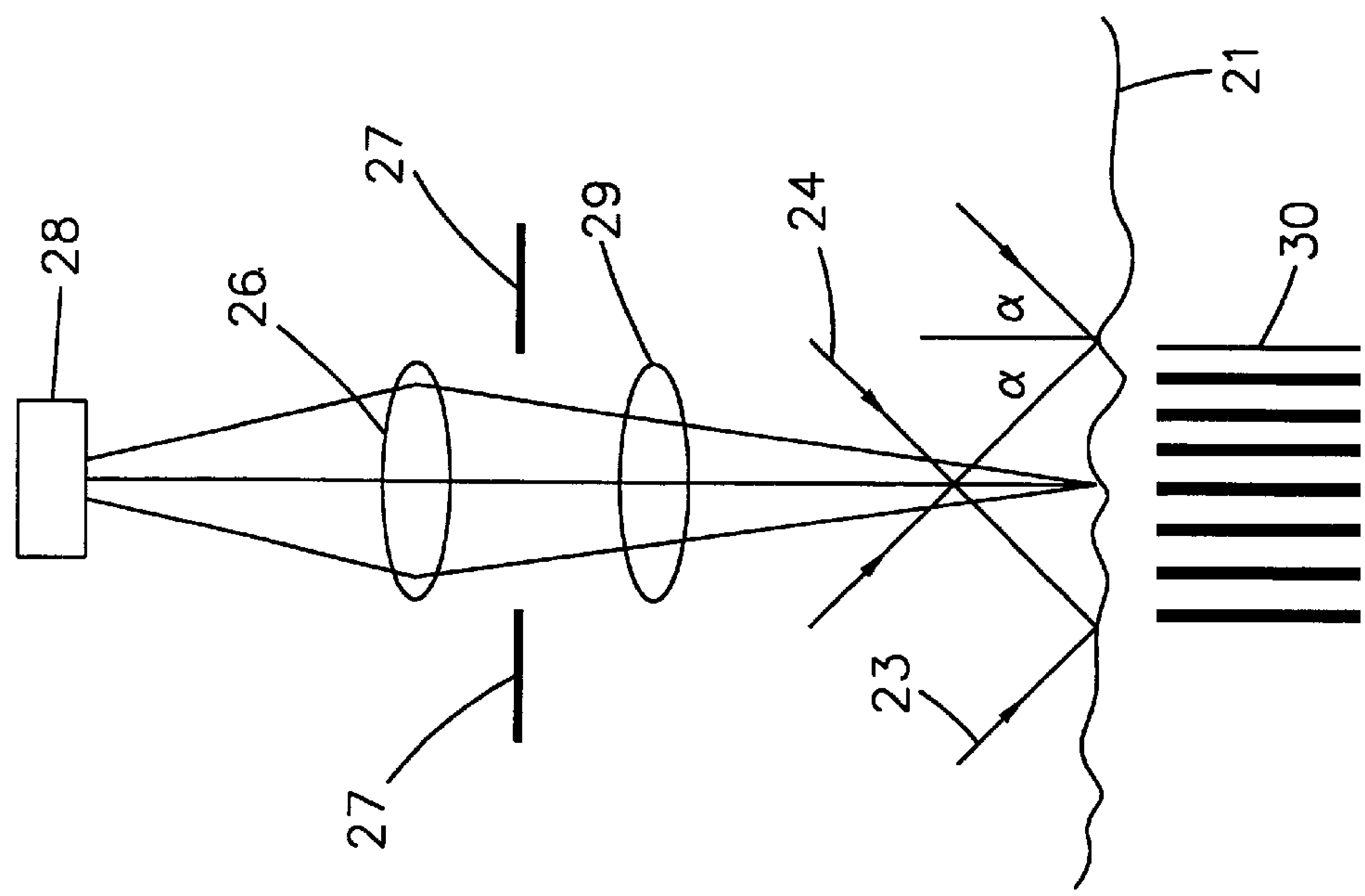

FIG. 3

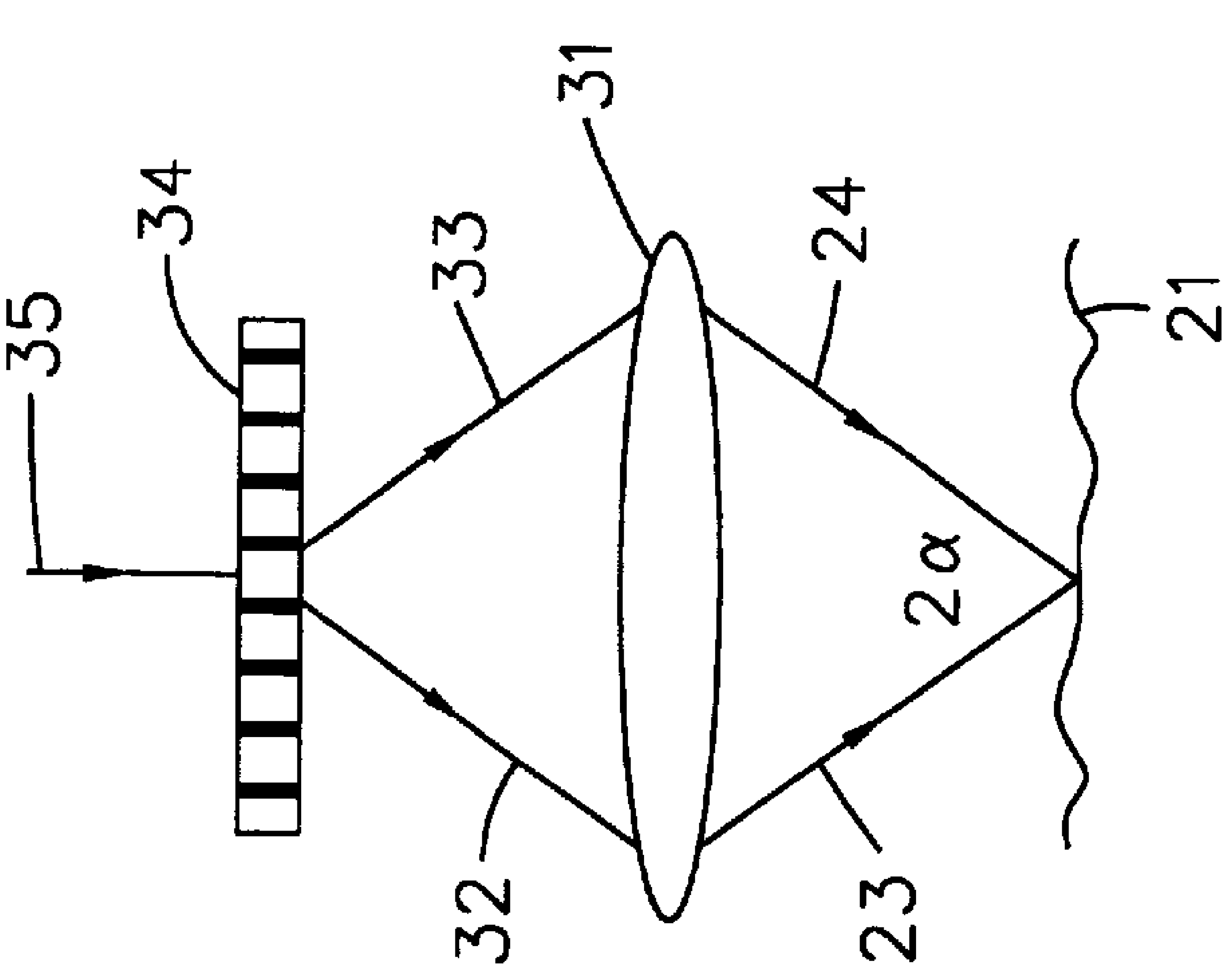

FIG. 2

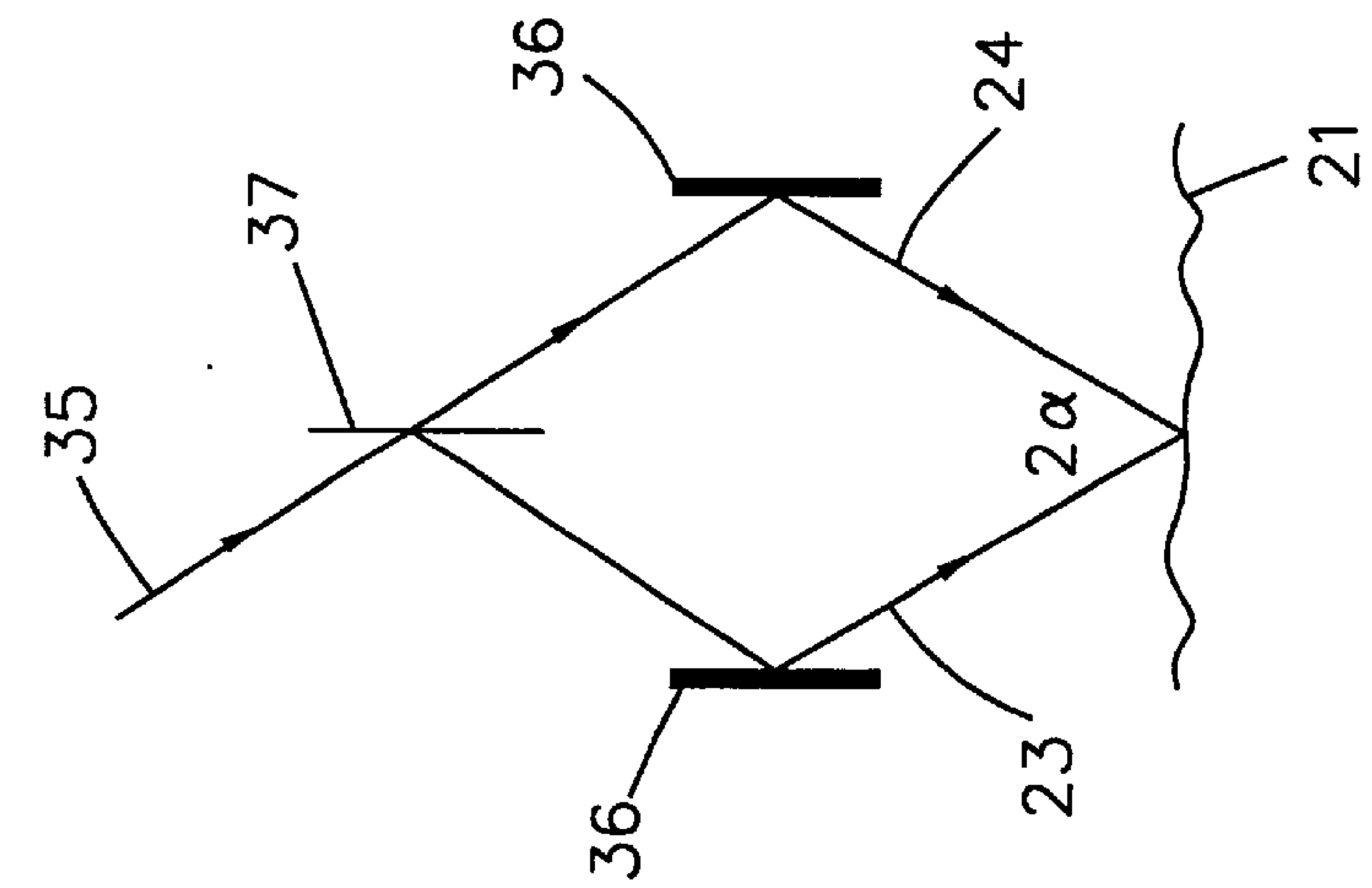

FIG. 4C

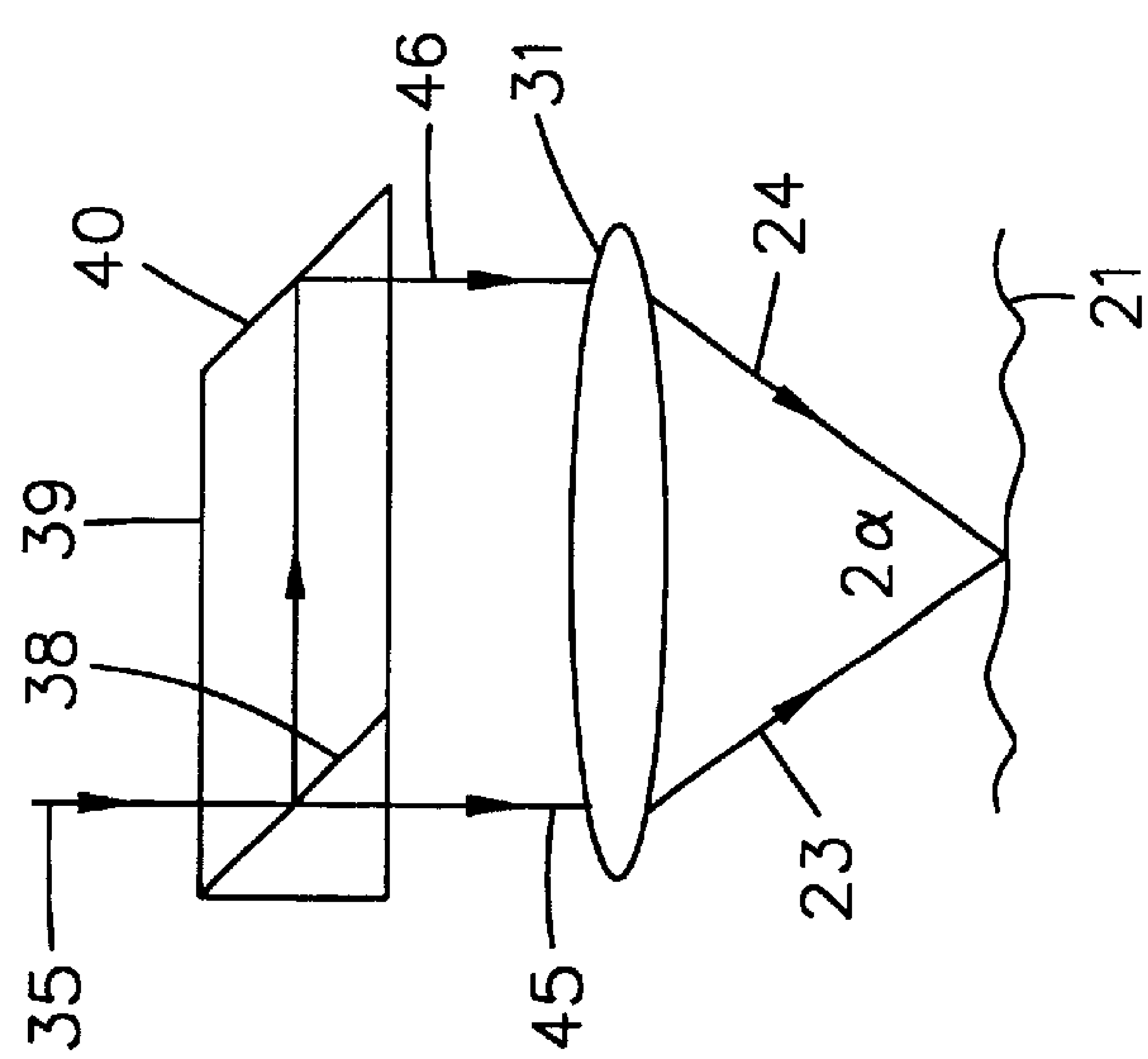

FIG. 4B

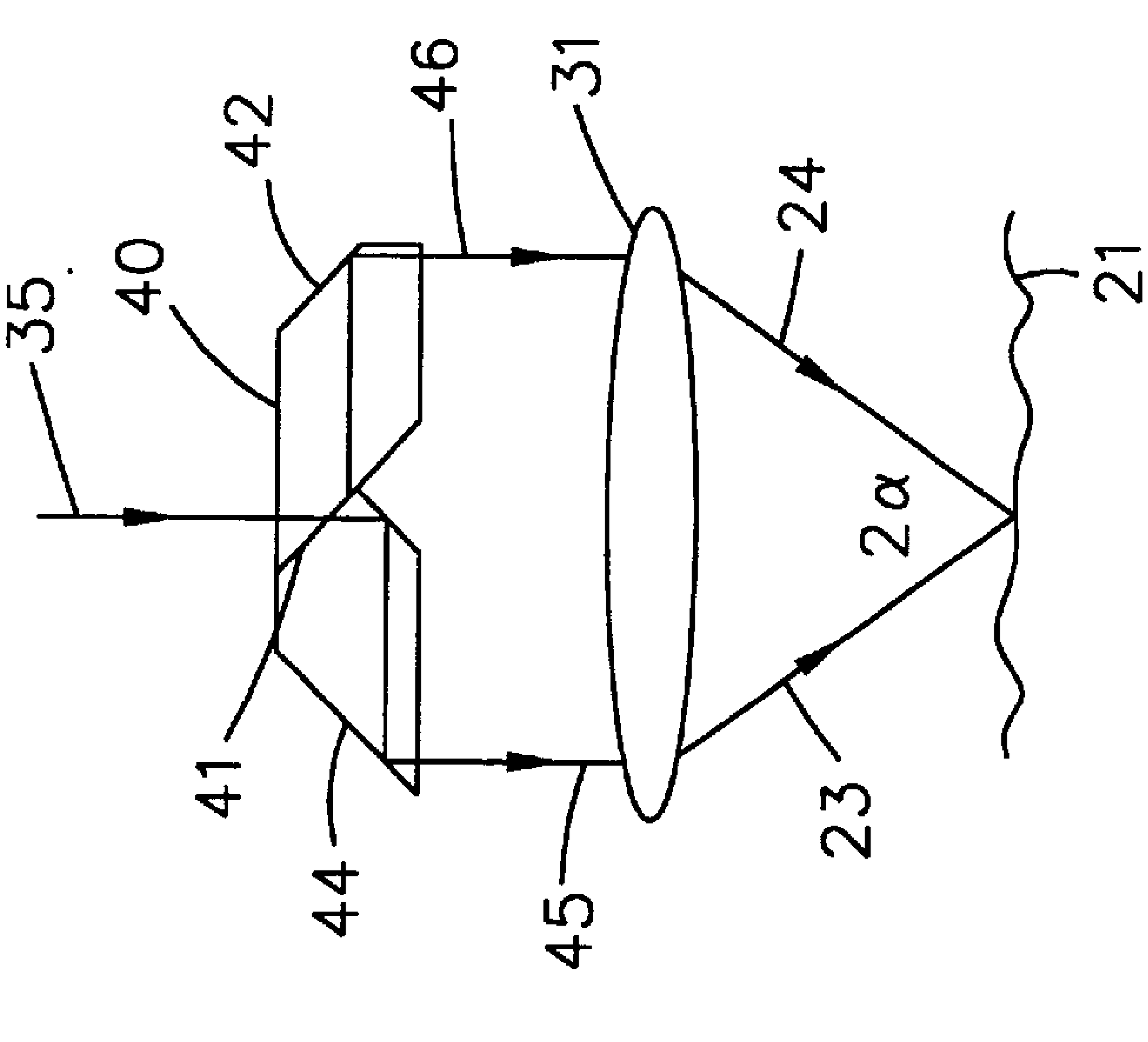

FIG. 4A

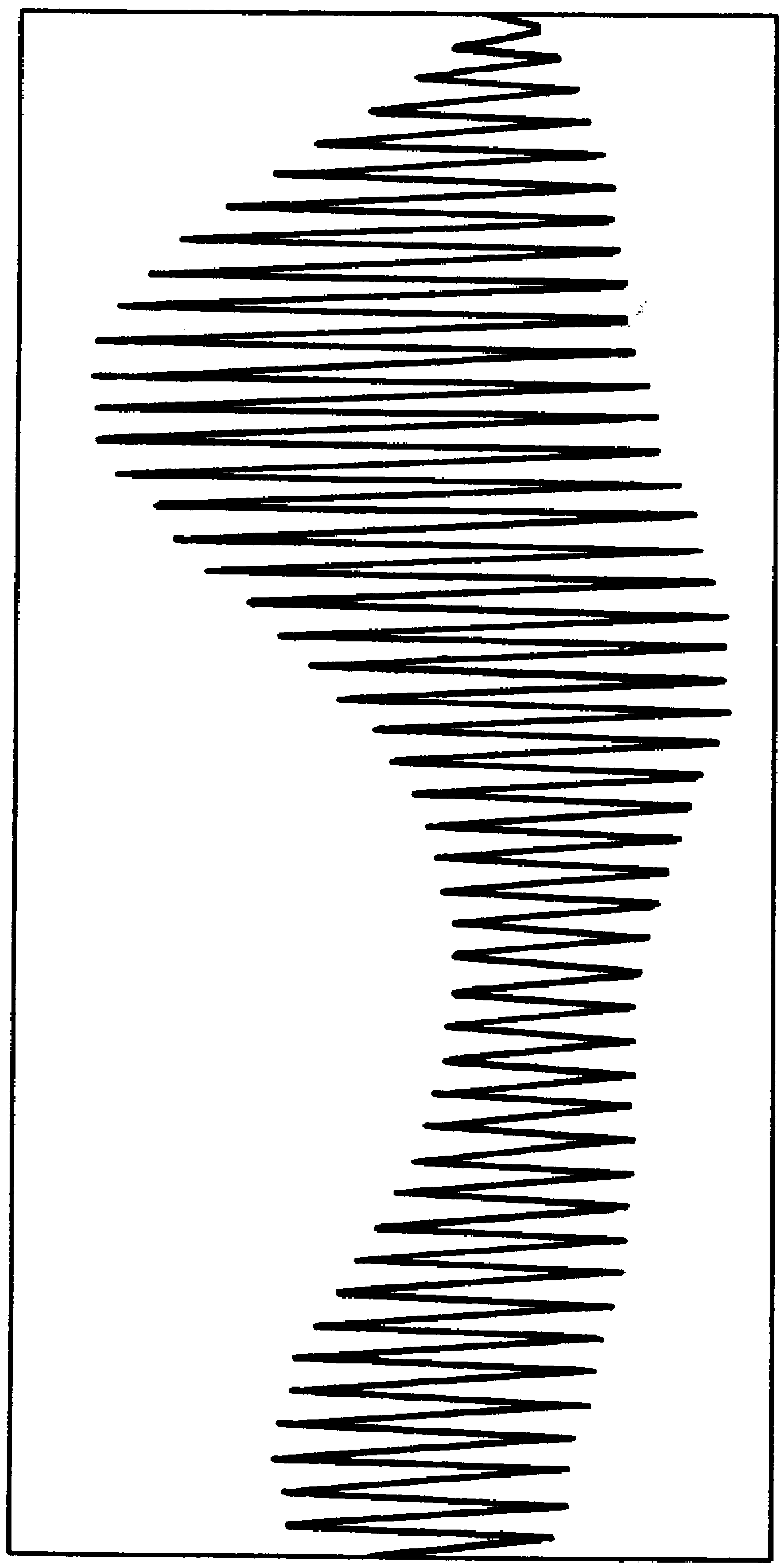

FIG. 5

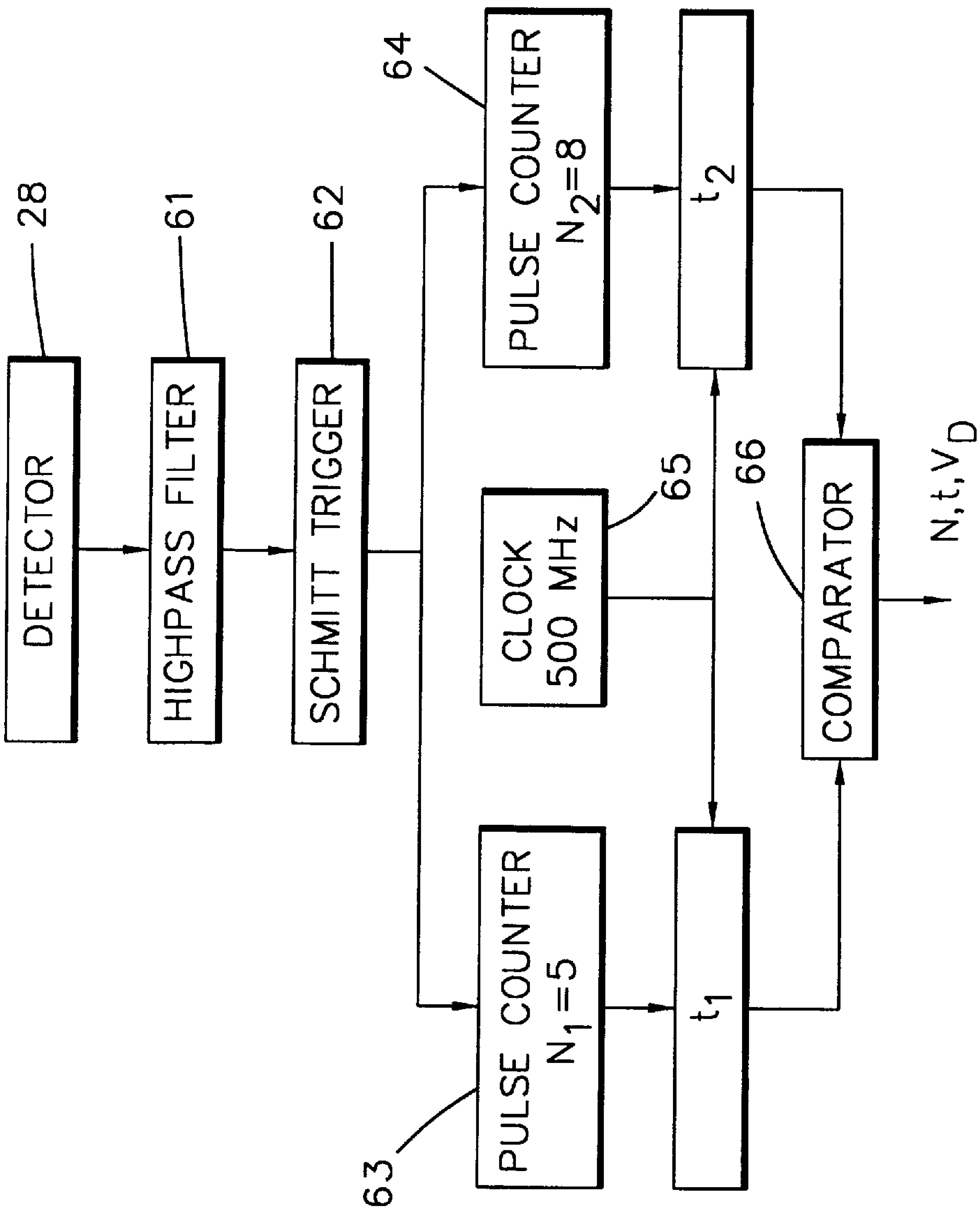
DETECTOR
28
HIGHPASS FILTER
61
SCHMITT TRIGGER
62
PULSE COUNTER $N_2=8$
64
t_2
CLOCK 500 MHz
65
66
COMPARATOR
N,t,V_D
PULSE COUNTER $N_1=5$
63
t_1

FIG. 6

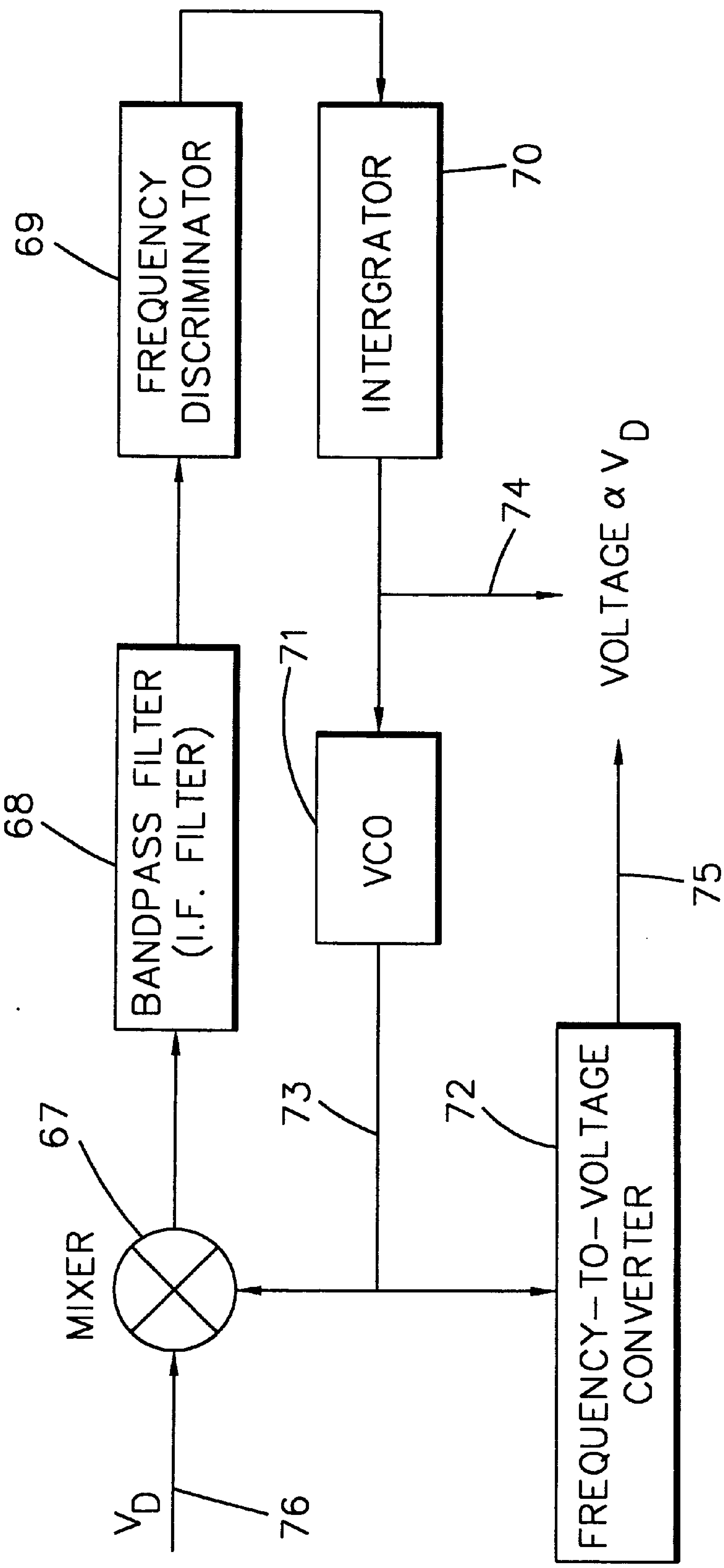
FREQUENCY DISCRIMINATOR
69
INTERGRATOR
70
BANDPASS FILTER (I.F. FILTER)
68
VCO
71
74
VOLTAGE α V_D
75
MIXER
67
73
72
V_D
76
FREQUENCY–TO–VOLTAGE CONVERTER

FIG. 7

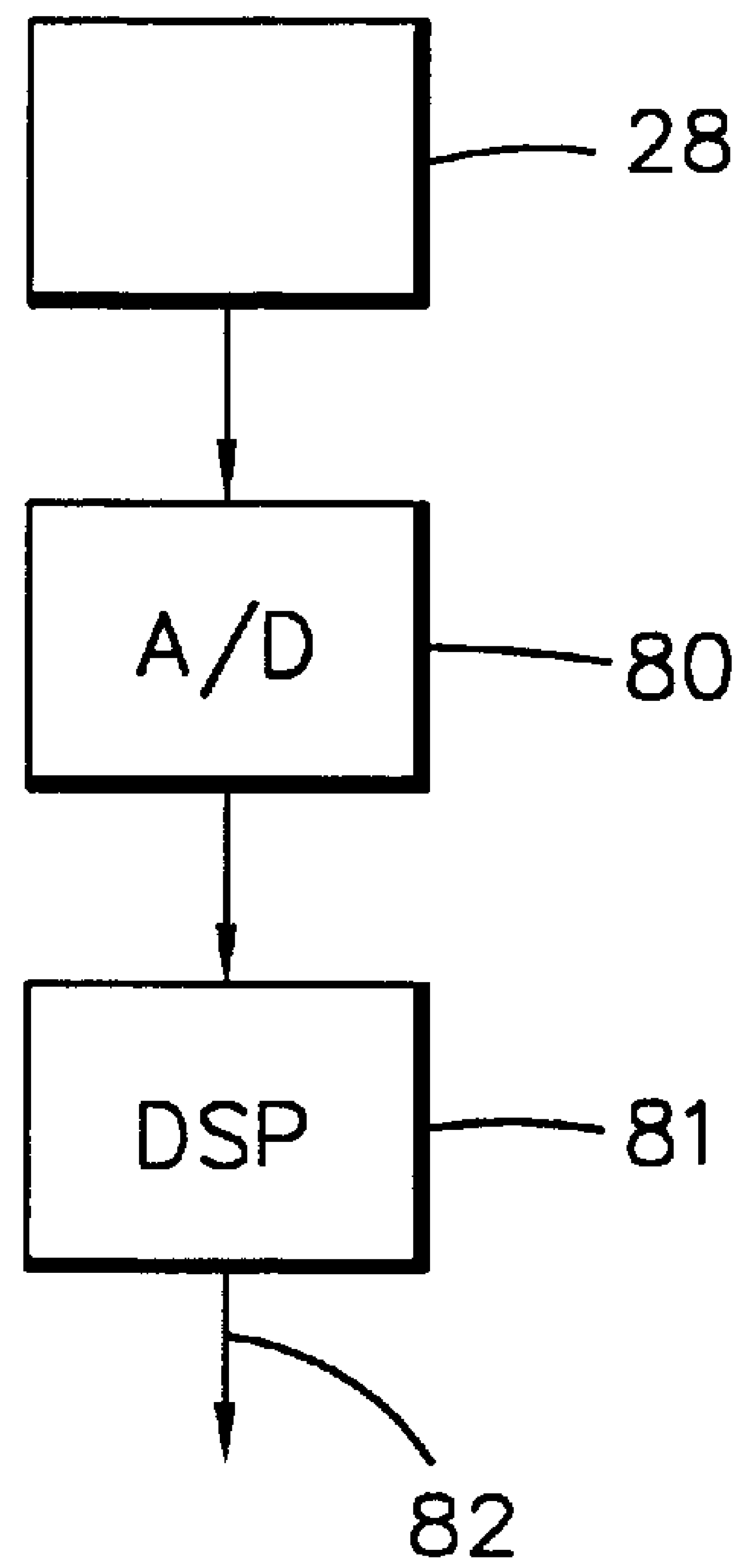

FIG. 8

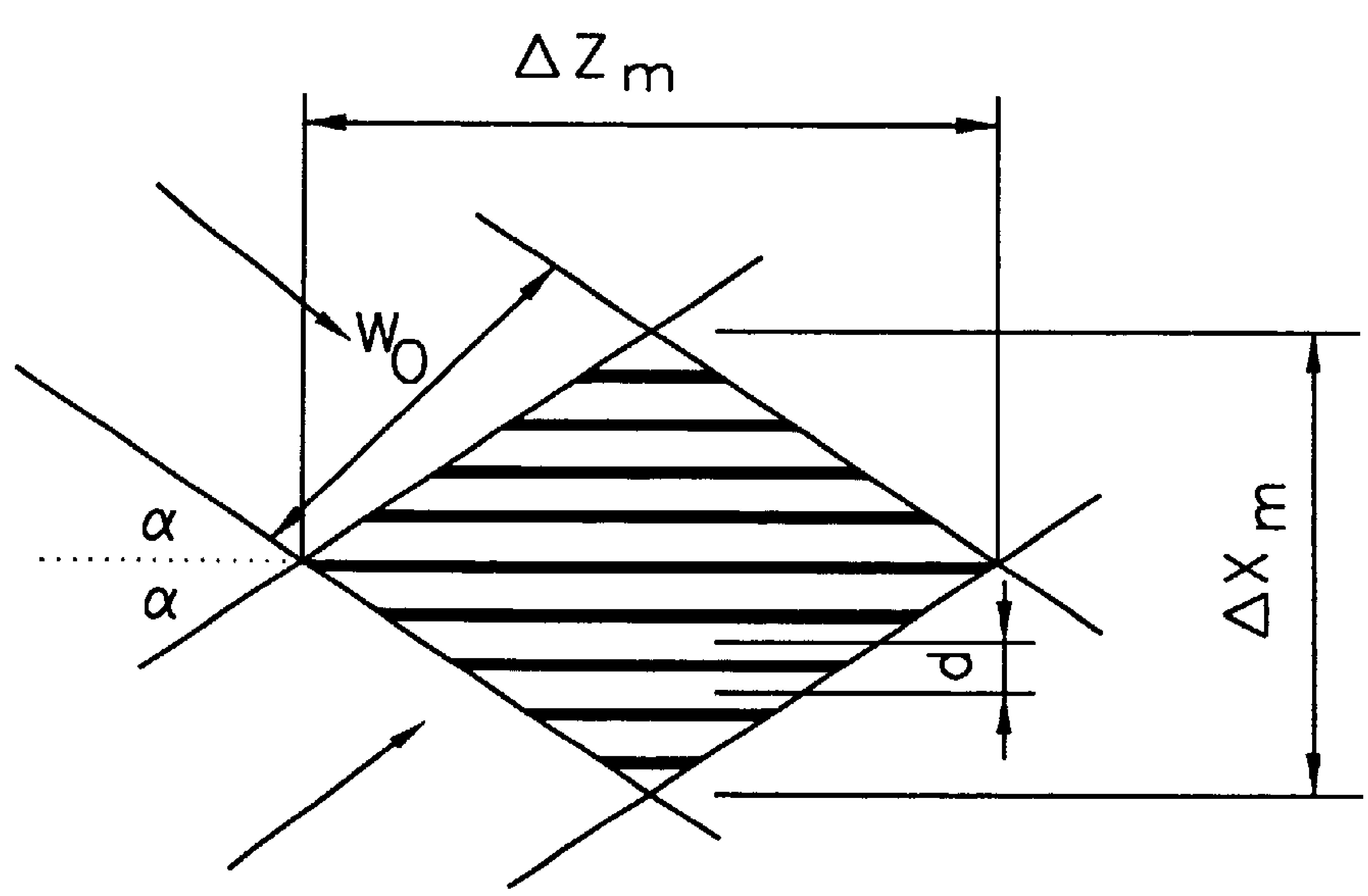

FIG. 9

DIGITAL POSTAGE FRANKING WITH COHERENT LIGHT VELOCIMETRY

This application is a continuation of Ser. No. 09/023,457, filed Feb. 13, 1998, which claims benefit of Provisional Appln. 60/068,434 filed Dec. 22, 1997.

The invention relates generally to the printing of digital postal indicia, and relates in particular to approaches for the non-contact measurement of velocity of a mail piece using interference patterns created by beams of coherent light.

BACKGROUND

For many decades it has been routine to print postal indicia by means of relief printing dies. By "relief dies" is meant dies in which the high points receive ink which is transferred to a mail piece. This is contrasted to intaglio print elements in which ink is applied to the entirety of the printing plate and removed from the high points, leaving ink only in the low points to be transferred to the paper. The relief printing die offers many advantages, among them that the image quality is very good due to the pressure applied by the die upon the mail piece, which tends to keep the mail piece captive and reduce the possibility of unwanted and unintended motion of the mail piece relative to the printing die. A person who might attempt to print postal indicia without paying for them would be faced with the task of creating a counterfeit printing die, or with the task of tampering with a postage meter (franking machine) to force its printing die to be used to print postage indicia that are otherwise unaccounted-for. The latter approach is unsatisfactory because the design of the postage meter is such that tampering is easy to detect through visual examination of the meter.

In such a postage meter there are accounting registers which account for postage indicia that are to be printed or that have been printed. For example, in some countries there will be a "descending register" and an "ascending register". The former keeps track of the postage value that was paid for in advance, and when the descending register drops to some predetermined level the meter refuses to print any more postage. The latter keeps track of the total amount of postage that has ever been printed on the postage meter. The accounting registers and the printing mechanism are all within a single secure housing, and this provides a confidence level that if a postage indicium has been printed, it has been accounted for in the accounting registers. The communications between the accounting registers and the printing mechanism are secure communications because of the secure housing.

The die printing is done with fluorescent ink which provides yet another confidence level against counterfeit postal indicia.

In recent years it has been proposed by some postal authorities to print postal indicia by means of digital printing methods such as ink jet and thermal transfer, and by the use of commonly available inks and transferred pigments. With such a digital printing method the print area is typically bit-mapped, and the mail piece typically moves relative. to the print head. As the mail piece moves relative to the print head, a bit-mapped data stream is communicated to the print head and ink or transferred pigment are deposited on the mail piece in response to the bit-mapped data stream. With many such proposed systems there is no physically secure communications channel between the accounting registers and the printer.

Of course it will be appreciated that if a commonly available printer (and ink or pigment) is used, there is a

substantial risk that some persons will be tempted to avoid having to pay for postage by the step of printing counterfeit postal indicia on mail pieces. This is particularly easy to do since the printed indicium could be scanned in a commonly available image scanner to arrive at a bit-mapped image that would, when printed, look quite like the original. Furthermore it will be recalled that in many such systems the communications channel between the accounting registers and the printer is, by definition, insecure. Thus the would-be counterfeiter can simply intercept the bit image of the postal indicium on its way from the accounting registers to the printer. This interception may be done in software (for example through the operating system) or in hardware (for example by capturing electrical signals passing through the Centronics-standard parallel printer cable).

The one measure that has been proposed to provide some level of protection against counterfeit postal indicia when commonly available printers are employed is the use of cryptographic authentication. The assumption is that there is a secure housing somewhere in the system, and within this housing are the accounting registers and also a cryptographic engine. The cryptographic engine is used, for example, to cryptographically "sign" the postal indicium. The post office may then examine the cryptographic signature on the mail piece and determine whether the indicium is authentic or counterfeit.

While the approach of the use of cryptographic signatures and commonly available printers is attractive from a theoretical point of view, there are practical drawbacks. It is easy enough to say that the indicium will include information that is to be examined by the post office, but on a practical level this will work only if the indicium, including the cryptographic signature, is machine-readable. It would be possible to use OCR (optical character recognition) characters that are optimized for scanning and recognition, or to use a bar code, for example a two-dimensional bar code. The US Postal Service has proposed the use of a two-dimensional bar code. The assumption is that nearly all mail pieces would be scanned and their indicia authenticated. This would require consistency checking for each indicium (e.g. that the cryptographic signature is consistent with the information that is "signed", such as the date and meter ID number). This would also require duplicate checking to ensure that a particular indicium has not been used more than once, since presumably the system is set up so that each indicium is supposed to be unique. The information proposed to be communicated by means of the two-dimensional bar code amounts to many hundreds of bits of data. The postal indicium thus would comprise a very large bar code as well as human-readable information that approximates a postal indicium of the type that is historically familiar.

Those with experience with postage meters will readily appreciate that a postal indicium which contains the images of a historically familiar indicium and that also contains a two-dimensional bar code of several hundred bits is quite sizeable and, importantly, is at risk of being smudged or otherwise damaged. If an inkjet printer is used, there is the concern that the indicium would be touched or smudged before the ink has dried. There is the further concern that if the indicium gets wet (for example, if the envelope is exposed to rain or other moisture) then the ink may smudge. In the case of a thermal transfer image, there is the concern that the thermally transferred pigment may be removed by abrasion or other perils. There is also the concern that the mail piece may not be perfectly constant in thickness, for example, if the envelope contents do not completely fill the envelope or if there is a staple or paper clip in the area where the indicium will be printed. These factors all work against the possibility that the two-dimensional bar code can be successfully read by the post office for reason of authentication.

Even if none of these perils occurs—no moisture, no smudging, no abrasion, no paper clip or staple—there is still the problem that the two-dimensional bar code must be printed faithfully in the first place. The horizontal and vertical spacing of the pixels that make up the bar code is required to be maintained accurately. This requirement applies to each pixel individually and there is the related requirement that the pixels be consistent in size across the vertical and horizontal extent of the bar code.

As will be appreciated, it would be very convenient if the designer of the digital printing franking machine were able to assume that the mail piece were always moving at an exact and very predictable velocity relative to the print head. In such a case, the data stream communicated to the print head could be clocked at a particular fixed rate, yielding an image in which everything is controlled and the image has all desired qualities.

As a general matter, however, the designer of the digital postage flanking machine is not able to assume that the mail piece is always moving at an exact and very predictable velocity relative to the print head. There can be variations of speed for mail pieces in the paper path depending on the number and types of mail pieces and their sizes. Many factors can contribute to the variations, such as the thickness of particular mail pieces and changes in the total mass of mail pieces that are within the paper path at a particular moment. A variation of speed over a relatively long interval relative to a desired speed can give rise to a postal indicium that is squeezed or stretched in its entirety in the axis parallel to the direction of motion of the mail piece. In such a case a printed pattern that is intended to form a circle would instead form an ellipse. On the other hand, variations of speed over relatively short intervals can give rise to a postal indicium that is irregular in its pixel dimension along the direction of motion. Any of these distortions of the bar code risks making the bar code unreadable for authentication purposes.

A commonly used approach for measuring the velocity of a mail piece is to place a roller in friction contact with the mail piece. The roller is coupled with a resolver or other sensor, and the resolver output is used to clock the print bit-map into the print head. This approach is not completely satisfactory, however. The roller may slip relative to the mail piece. The roller and the other moving, parts coupled to it present a rotational inertia which make it difficult for the roller to keep up with sudden changes in the velocity of the mail piece. The roller is also a maintenance item and the pressure with which it is biased toward the mail piece may need to be adjusted from time to time.

It is desirable to have a reliable way of measuring the velocity of a mail piece that is sufficiently accurate, lacks the drawbacks of the roller approach, and is not too expensive.

SUMMARY OF THE INVENTION

A postage meter (franking machine) uses a digital print head such as an ink-jet or thermal transfer or dot-matrix print head, for which it is necessary to know the velocity of the mail piece passing by the print head. Two collimated monochromatic beams strike the mail piece, one at an angle leading the mail piece velocity and the other at an angle lagging the mail piece velocity. The beams converge yielding a sensing region filled with a diffraction pattern. The mail piece, assumed to be rough at a scale that is appropriate for the velocity measurement, moves at some velocity. A detector detects light intensity (photon flux) at a small region within the sensing region, and the intensity signal has a frequency that is proportional to the mail piece velocity. The frequency is detected or measured, the instantaneous velocity is derived therefrom, and the velocity is used to control the print head. In this way a two-dimensional print image (postage indicium) is faithfully printed on the mail piece with minimal distortion even in the event of non-constant velocity of the mail piece.

DESCRIPTION OF THE DRAWINGS

FIG. **1** shows in cross section a system according to the invention;

FIG. **2** shows a light source for the system according to the invention;

FIG. **3** shows a detection optical path for the system according to the invention;

FIGS. **4***a*,**4***b*, and **4***c* show alternative light sources for the system according to the invention;

FIG. **5** shows a typical detected signal with a varying envelope;

FIG. **6** shows an exemplary signal processing circuit for the detected signal;

FIG. **7** shows an alternative signal processing circuit for the detected signal;

FIG. **8** shows another alternative signal processing circuit for the detected signal;

FIG. **9** shows the sensing volume for the system according to the invention.

DETAILED DESCRIPTION

FIG. **1** shows a system according, to the invention. A mail piece **21** moves rightward in FIG. **1** at a velocity v along, a defined axis x along, a paper path defined by a bed **20**. The velocity v may vary from time to time due to many factors. Perpendicular to bed **20** is a z axis. A print head **22** is positioned to be able to print on the mail piece **21**. The print head **22** is any print mechanism that benefits from careful measurement of the position and velocity of the mail piece **21**, and thus might be inkjet, thermal transfer, or other digitally imaged printing technology. The mail piece is not perfectly smooth but instead has some roughness when viewed on a sufficiently small scale.

The mail piece **21** is struck by light from two directions, as shown by rays **23** and rays **24**. Rays **23** approach the mail piece from behind, that is, the mail piece is moving away from the rays **23**. Rays **24** approach the mail piece from the front, that is, the mail piece is moving toward the rays **24**. The rays **23** and **24** are preferably monochromatic and are mutually coherent and each collimated. Rays **23** and **24** create an interference pattern on the mail piece **21**.

FIG. **1** also shows a sensor **28** and a focusing lens **26**. Light is able to pass from a sensing area **25** on the mail piece through the lens **26**, confined by mask **27** to an optical opening sized appropriately for the lens **26**. Light rays **29** show light passing from the sensing area **25** to the sensor **28**. Signal processing circuitry **50**, discussed in detail below, receives the signal from the sensor **28** and derives velocity information which is used to clock image information into the print head **22**. In this way, the print head **22** is able to print a properly formed image on the mail piece **21**. Sensor **28** is a photodetector such as a phototransistor. In an exemplary embodiment the sensor is not a spatial or linear array but simply measures light intensity (proportional to photon flux).

FIG. **2** shows a light source suitable for use in the system according to the invention. Mail piece **21** is shown with a rough surface (at an appropriate scale). A narrow beam **35** is preferably monochromatic and collimated, for example emitted from a laser diode omitted for clarity from FIG. **2**. The beam **35** passes through a an optical element **34** which gives rise to distinct beams **32** and **33**. Optical element **34** may be a phase grating. More generally the optical element **34** is any diffraction optical element (DOE). A DOE is an inexpensive optical component which works by diffraction from microstructures. DOEs are fabricated either interferometrically, or by direct writing or with the help of lithographic and etching methods derived from microelectronic technology.

The distinct beams **32**, **33** are refracted by lens **31** yielding beams **23**, **24** shown also in FIG. **1** along with mail piece **21**. The two means **23**, **24** strike the mail piece **21** defining an angle 2α.

FIG. **3** shows the mail piece **21** at a close scale with illustrative roughness. The beams **23**, **24** strike the surface with angle 2α between them. The beams generate a diffraction pattern **30** shown in FIG. **3**. Light rays **29** from a sensing region on the mail piece **21** pass upward in FIG. **3**, pass through an opening defined by mask **27**, and are refracted by lens **26** to be focused on sensor **28**.

There are other ways to create the mutually coherent collimated beams **23**, **24** in addition to the optical structure shown in FIG. **2**. For example, in FIG. **4***a,* a beam **35** strikes a prism **40** and reaches a partially reflective surface **41**, thereby splitting the beam **35**. One resulting beam **45** is reflected from mirrors **43** and **44**. The other resulting beam **46** is reflected from mirror **42**. The beams **45**, **46** are refracted by lens **31** to yield beams **23**, **24** which strike mail piece **21** and define an intersection angle 2α. In FIG. **4***b,* a beam **35** strikes a partially reflective surface **38** within prism **39** yielding two beams. Beam **45** is transmitted through surface **38**. Beam **46** is reflected from surface **38** and from mirror **40**. Beams **45** and **46** are refracted by lens **31** yield beams **23**, **24** which strike mail piece **21** and define an intersection angle 2α. In still another arrangement, beam **35** strikes partially reflective surface **37**, yielding beams **23**, **24** which are reflected from mirrors **36**. They strike mail piece **21** and define an intersection angle 2α. The arrangements of FIGS. **4***a,* **4***b,* and **4***c* are thought less desirable than that of FIG. **2**, because for best results the two beams should be highly symmetric. Preserving such symmetry requires that the mirrors be accurately positioned with tight tolerances. The partially silvered beam splitting surface must likewise be coated in such a way as to provide equal light intensity in both beams, to maximize the fringe (interference pattern) contrast.

A typical output signal from sensor **28** is shown in FIG. **5**. The frequency of the signal within the envelope is proportional to the instantaneous velocity. The modulation depth of the envelope varies from burst to burst and the signal may not be present at all times, that is, it may drop out. It is helpful to define a dropout rate which is the ratio between the times during which no signal is processed and the total time of the signal.

Recall from FIG. **1** that signal processing circuitry **50** is provided to process the signal (for example, that shown in FIG. **5**) to derive velocity information. Workable signal processing methods include burst counting, frequency tracking and fast Fourier transform (FFT) analysis.

One way to do burst counting is to preferably high-pass-filter the signal from the sensor **28**, as shown in one embodiment in FIG. **6**, and pass the signal through a Schmitt trigger **62**. It may optionally be mixed with a local oscillator to provide a convenient working frequency. Then a fixed gate time is preset and the number of zero crossings in this interval is counted and the frequency calculated. Alternatively, as shown in FIG. **6**, the time taken for a fixed number of zero crossings is measured as in boxes **63**, **64**.

Many sources of error exist and they must be provided for to the extent possible. For example, the zero crossings may be separated by unequal time intervals. Spurious zero crossings may occur due to noise, although hopefully the Schmitt trigger and other measures will reduce this. Some zero crossings may be missing due to poor signal-to-noise ratio. For these reasons, various electronic schemes have been developed to reject incorrect bursts, for example by making. Comparison between N_1=5 and N_2=8 cycles, as shown in FIG. **6** in boxes **63** and **64** respectively.

A burst counter requires a higher signal-to-noise ratio than some other signal processing techniques. But the burst counter approach does not require a continuous signal and can function well even with high dropout values.

Another approach is the frequency tracker of FIG. **7**. The analog, output from the detector **28** (omitted for clarity in FIG. **7**) is mixed at **67** with a sinusoidal signal from a voltage-controlled oscillator (VCO) **71** which is in a feedback loop. The mixed signal is passed through a narrow bandpass filter **68** and a frequency discriminator **69**. This signal is integrated at **70** and the output controls the VCO **71**. The integrator **70** regulates the transient response and the stability of the feedback loop. The VCO frequency (at line **73**) thus tracks the frequency of the incoming analog signal (at line **76**) from the detector **28**. The input signal (at line **74**) of the VCO **71** is proportional to the instantaneous input frequency.

As shown in FIG. **7**, a frequency-to-voltage convertor **72** may optionally be used to derive a voltage (at line **75**) proportional to the input frequency. This gives better linearity than monitoring the signal at **74**.

The chief disadvantage of the approach shown in FIG. **7** is that it requires a near-continuous input signal at **76**. In the case where the input signal at **76** is not continuous, a lock-on lock-off mechanism must be provided to hold the last known measured frequency until a new signal arrives.

Still another approach is the performance of a fast Fourier transform (FFT) in real time using digital signal processing (DSP) technology. In a typical embodiment, the raw signal from the detector **28** (see FIG. **8**) is passed to an analog-to-digital (A/D) converter **80**. The digital signal is passed to a DSP **81**. The DSP FFT approach is quite effective at discriminating the velocity signal from background noise.

There are several choices for the positioning of the velocity sensing optics (FIG. **1**, items **28**, **26**, and the light sources yielding rays **23**, **24** in FIG. **1**) relative to the print head **22** (FIG. **1**). For simplicity of portrayal the optics in FIG. **1** are shown upstream of the print head **22**. But nothing in the invention requires this relative positioning. For example, it may prove desirable that the optics be positioned neither upstream nor downstream but instead in the Y axis in FIG. **1** relative to the print head **22**. It might also prove desirable to position the optics on the opposite side of the mail piece from the print head, optionally opposed to the print head **22**.

The underlying optics theory will now be described. One way to describe the measurement technique is to define a displacement of the mail piece in the x-direction u_x which results in an optical phase difference between the two interfering beams given by:

$$\Delta\varphi = \frac{4\pi\sin\alpha}{\lambda}u_x = \frac{4\pi\sin\alpha}{\lambda}vt$$

In this equation the displacement u_x is related to the mail piece velocity by u_x=vt. From this equation, the frequency of the interference signal is expressed by

$$\nu = \frac{1}{2\pi}\frac{d}{dt}(\Delta\varphi) = \frac{2\sin\alpha}{\lambda}v$$

Another way of describing the velocity measurement is in terms of the classical Doppler effect. In FIG. **1** the beam **24** is scattered with a positive Doppler frequency shift, while the beam **23** suffers a frequency reduction after scattering. Therefore, the light scattered from the rough surface experiences an intensity modulation with a frequency v_D proportional to the speed of the surface v in the x-direction, namely:

$$\nu_D = \frac{2\sin\alpha}{\lambda}v$$

It should be appreciated that v sin α is the projection of the velocity v in the direction of either of the laser beams. The frequency detected in this way does not depend on the direction of the observation (or detection). This is a great advantage for the design of the sensor head.

It is beneficial to have a probe volume filled with fringes that are separated by exactly the same distance d as shown in FIG. **9**. Variations in the spatial period d will lead to errors in the measured mail piece velocity. Such a problem may occur if the two beams do not cross and strike at the same point, resulting in a fringe divergence.

Assuming two identical beams **23, 24** illuminating the rough surface, it is possible to define the sensed region (probe volume) with dimensions Δx_m, Δy_m and Δz_m given by

$$\Delta x_m = \frac{2w_0}{\cos\alpha}$$

$$\Delta y_m = 2w_0$$

$$\Delta z_m = \frac{2w_0}{\sin\alpha}$$

where **2**α is, as before, the mutual angle of the illuminating directions (FIG. **2**) and w_0 is the beam width (radius). It should be mentioned that Δz_m corresponds approximately to the depth of field of the measurement system. Stated differently, the magnitude of Δz_m gives an approximate indication of the extent to which a mail piece might be slightly higher or lower relative to the bed **20** and still have a successful velocity measurement.

The number of interference fringes in the probe volume is approximately

$$N_f = \frac{\Delta x_m}{d} = \frac{4w_0}{\lambda}\tan\alpha$$

In an exemplary arrangement the beam width might be w_0=2 mm, the wavelength might be λ=780 nm. For α=45 degrees, the probe volume dimensions are about Δx_m=5 mm, Δy_m=2 mm, and Δz_m=5 mm and the number of fringes is about ten thousand.

Using the optics and related circuitry described herein, the measuring accuracy is dependent solely on the wavelength of light used and the angle (**2**α) at which the beams strike the mail piece. The measurement accuracy is not sensitive to vibrations or dust or variations of temperature or humidity. The motion sensor head can be compact. The optical system is quite simple—a lens, a photodiode or phototransistor, a light-emitting diode, and a diffraction grating or other diffraction optical element. The measurement is non-contact which is advantageous.

What is claimed is:

1. A postage meter comprising a digital print head and a velocity sensor having an output, said postage meter having a bed defining a paper path with a direction, said digital print head and said velocity sensor positioned along said paper path; said velocity sensor comprising a light source and a light sensor, said light source comprising first and second monochromatic collimated beams, said first beam impinging upon said paper path at a first angle leading said direction and defining a sensing area, said second beam impinging upon said sensing area at said first angle lagging said direction, said first and second beams yielding a diffraction pattern within said sensing area; said light sensor sensing light intensity at a region within said sensing area, said velocity sensor further comprising a frequency detector responsive to said sensed light intensity yielding a signal indicative of the measured frequency, said signal comprising the output of the velocity sensor; said print head operatively coupled with said velocity sensor output.

2. The postage meter of claim **1** wherein the light source further comprises a diffraction optical element, a convex lens, and a laser diode, light emitted by said laser diode passing through said diffraction optical element and being split thereby into two divergent beams, said two divergent beams passing through said lens and being refracted thereby to converge in the sensing area.

3. The postage meter of claim **1** wherein the light sensor comprises a concave lens focusing light from the region within the sensing area onto a photodiode or phototransistor.

4. The postage meter of claim **1** wherein the sensing area, is positioned neither upstream nor downstream relative to the print head with respect to the direction.

5. The postage meter of claim **1** wherein the sensing area is positioned on the opposite side of a mail piece from the print head.

6. The postage meter of claim **5** wherein the sensing area is positioned neither upstream nor downstream relative to the print head with respect to the direction.

7. The postage meter of claim **6** wherein the sensing area is opposed to the print head.

8. The postage meter according to claim **1** wherein a mail piece is positioned on the bed defining the paper path and moves in the direction, and wherein when the moving mail piece reaches the sensing area the first beam impinges upon the mail piece at the first angle leading the direction.

9. The postage meter of claim **1**, wherein a mail piece is positioned on the bed defining the paper path and moves at a velocity, and wherein the velocity sensor is adapted to determine the velocity of the mail piece for triggering a printing of a postal indicium on the mail piece in a predetermined location.

10. The postage meter of claim **9** wherein the velocity of the mail piece is variable with respect to a velocity of the bed defining the paper path.

11. The postage meter of claim **1** wherein a mail piece is positioned on the bed defining the paper path, the mail piece having a non-smooth surface and wherein the output of the velocity sensor is a velocity of the mail piece.

12. The postage meter of claim **1** wherein the velocity sensor measures a velocity of a mail piece on the bed defining the paper path irrespective of a velocity of the bed defining the paper path.

13. The postage meter of claim **1** wherein the sensing area is positioned in a Y-axis relative to the print head.

14. The postage meter of claim **1** wherein a mail piece is positioned on the bed defining the paper path, the mailpiece having a non-constant thickness.

15. A method for printing a postage indicium on a mail piece moving with a velocity in a direction, said method comprising the steps of:

causing first and second monochromatic collimated beams to impinge upon said mail piece, said first beam impinging upon said mail piece at a first angle leading said direction and defining a sensing area, said second beam impinging upon said sensing area at said first angle lagging said direction, said first and second beams yielding a diffraction pattern within said sensing area;

sensing a light intensity at a region within said sensing area,

measuring, the frequency of the light intensity; and

operating a print head in response to the measured frequency to print a postage indicium upon the mail piece.

16. The method of claim **15** further comprising creating said first and second beam by passing, light through a diffraction optical element yielding two divergent beams, and passing the two divergent beams through a convex lens.

17. The method of claim **15** wherein the mail piece is located on a moving bed defining a paper path.

18. The method of claim **15** wherein the mail piece has a non-smooth surface.

19. The method of claim **15** wherein the mail piece is moving with a velocity irrespective of a velocity of a moving bed defining a paper path on which the mail piece is located.

20. The method of claim **15** further comprising the steps of:

maintaining a constant velocity for a bed defining a paper path on which the mail piece is moving; and

adjusting a timing for printing the postage indicium on the mail piece based on the velocity of the mail piece as determined by the measured frequency.

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